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SciVerse ScienceDirect
Systems Engineering Procedia 4 (2012) 455 – 459
Procedia
Systems Engineering

Rent-seeking Behaviors analysis in Engineering Supervision based on the Game Theory

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Abstract

Based on the theory of rent-seeking, this paper analyzes the behaviors and relationships between the owner, supervision and contractor in engineering supervision. The paper establishes a game model of the engineering rent-seeking behavior and relationship. Based on the game equilibrium solution, a conclusion is drawn that owner should improve the monitoring efficiency and make powerful punishment to rent-seeking behaviors in order to effectively restrain the rent-seeking behaviors in engineering supervision.

Keywords: Engineering supervision; rent-seeking behavior; game theory;

1. Introduction

Supervision industry has developed for more than twenty years in China. However, there are still many problems in the development of supervision industry, such as the insufficient number and low quality of employees, weak sense of responsibility, illegal practices and so on[1-3]. Furthermore, many factors, such as the imperfect law, regulation system, extensive industry protection, local protection, administrative intervention and regional segmentation, lead to weak standardized of supervision market and shortage of a truly fair, just and open competition environment. Therefore the rent-seeking and other immoral behaviors occurred[4-7].

2. Rent-seeking Theory

Rent-seeking is an unproductive activity for profit, and a behavior using resources and taking legal or illegal means to gain privileges as well. Thus causing damage to others' interests which are greater than the rent winner's incomes. For example, sometimes privileges of rent possession are obtained by lobbying and bribery. The results of rent-seeking activities are: the fair competition was destroyed, allocation of economic resources was distorted; resources that could be used for productive activities were wasted on the activities that are not conducive to social development; socio-economic efficiency was reduced, the implementation of more efficient mode of production was hindered. Moreover, if these activities leave the production field and play a role in the circulation, other levels of rent-seeking or rent-avoiding will be resulted.

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 doi:10.1016/j.sepro.2012.01.010

3. The Relationships Between Tripartite Rent-seeking Behaviors

The behavior subjects of rent-seeking activities that this paper researches and analyzes are mainly owner, supervision unit, and contractor.

First, contractors and owners have an asymmetric characteristic in the information respect. In the process of project construction, contractors know about the work and the environment better than owners. They grasp more professional knowledge, variety kinds of technical solutions and quality standards. Moreover, contractors always have some private information that owners don't know, for example, the resource input and transformation processes, whether their engineering skills are consistent with the project requirements or not, and so on. Owners are also difficult to observe contractors' actual payment directly. In order to pursue their own interests to maximize, contractors will likely to cheat owners for high profits by multi-level contracting, jerry-building or other methods. Even if owners can foresee these behaviors, it is still difficult to prevent. Consequently, owners always tend to delegate supervisors to supervise and manage contractors.

Meanwhile, information from supervision units is also incomplete, because owners cannot completely know their level of management, technical strength and other private information. In addition, supervisors are not the ultimate beneficiaries of safety construction, even though they are on behalf of owners' rights in a certain range and have the right to manage the project. In order to obtain additional income, project supervisors probably abuse their power of attorney to collude with contractors and implement direct non-productive activities when their behaviors can not be observed by owners completely, such as fraud, forging data and files, lowering the project quality, signing unqualified engineering, materials, components and equipments with "qualified"; thus resulting in rent-seeking behaviors. These will cause significant security risks to project quality.

According to economics principle, from the angle of profit maximization: supervision units need to gain supervision business or get supervision income that beyond the normal payment in the nonstandard market; and contractors have to obtain supervisors' permit firstly if they want profits that outside of normal income rage, like getting extra claim proceeds or extending more duration. Therefore, supervisions and contractors probably seek additional revenue through rent-seeking behaviors.

Moreover, China's engineering supervision companies widely have shortcomings, such as pinch of professionals, low quality of employees, and so forth. If the supervisors do not have enough strength or do not perform their supervisory duties, contractors will find ways to make their own irregularities avoid the supervision, which will bring about decreasing the project quality. Another situation is supervisors have the strength: if they supervise conscientiously according to the contract and regulations, contractors' irregularities will hardly escape from their supervision; if supervision units are also in pursuit of excess profits, they may violate professional ethics and be bribed to collude with contractors, thus cause rent-seeking behaviors and affect the project quality and safety seriously.

4. Game Model Analysis of Tripartite Rent-seeking Behaviors

4.1. Model Building

This article takes the owner, supervision unit and contractor as the three behavior subjects of the game. We assume that there are two strategies for supervision unit and contractor: choose rent-seeking or not; in allusion to their choices the owner also have two strategies: monitor them or do not monitor; and there are also two results of monitoring: find out rent-seeking behaviors or do not find out. Once the rent-seeking behaviors are found out, they will be punished appropriately. So in these cases, the model conditions are as follows:

(1) The relationship between owner and the other two is non-cooperative game; the probability of owner's monitoring and managing rent-seeking activities is α ; the probability of monitoring success is β ; the probability that contractor chooses rent-seeking is θ .

(2) In rent-seeking situation, assuming the available excess profits that contractors can obtain is P, the owner's cost for monitoring rent-seeking activities is C, the rent that contractor pay to supervision units is R(R＜P).

(3) If supervision unit and contractor do not take rent-seeking activities, and owner does not monitor them, then their proceeds are all 0.

(4) If supervision unit and contractor do not take rent-seeking activities, but owner monitor them, then the proceeds of supervision unit, contractor and owner are 0, 0, −C.
(5) If supervision unit and contractor take rent-seeking activities, but owner do not monitor, their proceeds are R, P−R, −P.
(6) If the supervision unit and contractor take rent-seeking activities, and owner monitor them, but do not detect their behaviors, then their proceeds s are R, P−R, −P−C.
(7) If the supervision unit and contractor take rent-seeking activities, the owner monitor them and find out their behaviors, then the owner will: confiscate proceeds of supervision units and punish them f_1R; confiscate proceeds of contractors and punish them f_2 (P−R). Besides, we set $f_1$and f_2 as penalty coefficient. Then the proceeds of supervision unit, contractor and owner are $-f_1R$, $-f_2(P-R)$ −R, $f_1R+f_2(P-R)+R-C$.

According to assumption conditions of the tripartite game, thus gain the payoff matrix as table1 shown.

Table1. Payoff matrix of supervision units, contractors and owners

Supervision unit and Contractor	Owner and construction safety monitoring agency		
	Monitor(α)		No monitor ($1-\alpha$)
	Detect (β)	No detection ($1-\beta$)	
Rent-seeking (θ)	$-f_1R$ $-f_2(P-R)-R$ $f_1R+f_2(P-R)+R-C$	R P−R −P−C	R P−R −P
No Rent-seeking ($1-\theta$)	0 0 −C	0 0 −C	0 0 0

Note: In the model, the data of first rows are supervision units' proceeds, second rows is contractors' proceeds, and the third rows are owners'.

4.2. Model Analysis

According to the tripartite game conditions and payoff matrix:

(1) The owner's expected proceeds that choose monitor or not are as follows:

$E_1=\theta\{[f_1R+f_2(P-R)+R-C]\beta+(-P-C)(1-\beta)\}+(1-\theta)[-C\beta-C(1-\beta)]$

$E_2=\theta(-P)+(1-\theta)\times 0=-\theta P$

We make $E_1=E_2$, then work out $\theta^*=C/\beta[(f_1-f_2+1)R+(f_2+1)P]$. That means θ^* is the optimal probability of taking rent-seeking activities for supervision unit and contractor when owner's expected proceeds are the same.

(2) If the owner chooses to monitor them, the expected proceeds that supervision units choose rent-seeking or not are:

$E_3=\alpha[-f_1R\beta+(1-\beta)R]+(1-\alpha)R$

$E_4=0$

We make $E_3=E_4$, then come out $\alpha_1^*=1/\beta(1+f_1)$, which means the optimal probability of owner's monitoring when the supervision unit's proceeds are the same.

(3) If the owner chooses to monitor them, the expected proceeds that contractors choose rent-seeking or not are:

$E_5=\alpha\{[-f_2(P-R)-R]\beta+(P-R)(1-\beta)\}+(1-\alpha)(P-R)$

$E_6=0$

We make $E_5=E_6$, then get $\alpha_2^*=(P-R)/\beta[(1+f_2)P-f_2R]$. It is the optimal probability of owner's monitoring when the contractor's proceeds are same.

To sum up the above calculations, we get Nash equilibrium solution of the tripartite game mixed strategy:

$\{\theta^*, \alpha_1^*\}=\{C/\beta[(f_1-f_2+1)R+(f_2+1)P], 1/\beta(1+f_1)\}$ and

$\{\theta^*, \alpha_2^*\}=\{C/\beta[(f_1-f_2+1)R+(f_2+1)P], (P-R)/\beta[(1+f_2)P-f_2R]\}$

5. Example Analysis

The owner contracted a project to the contractor which quote price 22.7 million Yuan, and commissioned a supervision unit to supervise and manage the project. In the course of project implementation, contractor asks the supervision unit for rent-seeking in order to obtain additional income. If their rent-seeking success, contractor will pay 100,000 Yuan to the supervision unit, and will gain rent-seeking benefit 500,000 Yuan. So the rent-seeking behavior will make the whole project's price from 22.7 million to 23.3 million Yuan. The owner cost 150,000 Yuan in order to avoid unethical behaviors between contractor and supervision unit, make the project go smoothly, and achieve the targets of controlling quality, cost, schedule, and so on. Their project supervision contract states that: if the owner finds out unethical behaviors, they will confiscate the rent-seeking income, penalize supervision unit 3 times of the money and penalize the contractor 2 times of rent-seeking income. So we know that R＝100,000; P＝600,000; C＝150,000; f_1＝3; f_2＝2. Now we assume the successful monitoring probability β=0.7. According to table 1 and above data, the payoff matrix can be drawn as table 2.

Table2. Payoff matrix of example

Supervision units and Contractors	Owners and construction safety monitoring agency		
	Monitor(α)		No monitor ($1-\alpha$)
	Detect (0.7)	No Detection(0.3)	
Rent-seeking (θ)	−300,000 −1,100,000 1,250,000	100,000 500,000 −750,000	100,000 500,000 −600,000
No rent-seeking ($1-\theta$)	0 0 −150,000	0 0 −150,000	0 0 0

Note: The data of first row are supervision units' proceeds, the second row is contractors' proceeds, and the third row is owners' proceeds.

Based on the equilibrium solution that comes out from the model analysis and table 2, we get the equilibrium: $\{\theta^*, \alpha_1^*\}$ = (0.11, 0.357) and $\{\theta^*, \alpha_2^*\}$ = (0.11, 0.446). It shows that, the probability θ of taking rent-seeking activities and the losses caused by rent-seeking are correlative. When $\theta < 0.11$, the owner could choose not to monitor because the loss is smaller. When the owner's monitoring probability $\alpha > 0.357$, the supervision unit should not choose rent-seeking. And when $\alpha > 0.446$, the contractor should not choose rent-seeking.

6. Conclusion and Countermeasures

According to game analysis, equilibrium solution and example analysis, conclusions are drawn through the tripartite subjects' behaviors analysis in engineering construction: (1) the optimal probability of rent-seeking is inversely proportional to owner's monitoring probability and penalty coefficient; (2) the optimal probability of rent-seeking is directly proportional to owner's monitoring cost. In order to efficiently reduce occurrence probability and increase the intendance probability of rent-seeking activities, the supervision control of construction activities should be strengthened, owners should intensify internal management with minimize costs, monitor and verify those activities more efficiently, and increase the strength of punishment. Moreover, reduction of the rent-seeking monitoring costs also depends on the improvement of owner's monitoring efficiency. Therefore, in order to strengthen the supervision of rent-seeking activities, they should clear out the intensity of punishment by contract, and pay attention to the improvement of monitoring efficiency as well.

With the development of construction industry, the situation of construction management system has changed. Requirements on the project supervision are also became higher. Under new situations and requirements of construction industry, the supervision units should improve supervision organization, pay attention to employees' qualifications and credit management, improve supervisors' professional quality and ethical quality, and enhance their own strength. In addition, the supervision industry should develop relevant laws and regulations at the same time, increase the management intensity of internal supervision units, and strengthen the legal system of construction market, so that project supervision can embark on the legalized road, and continue to play an important role in engineering construction.

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